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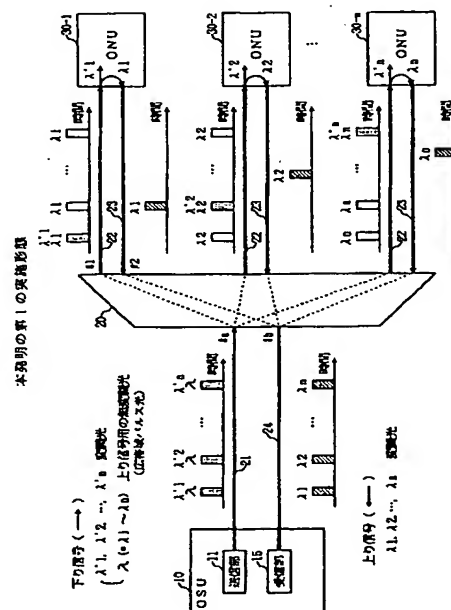
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(54) 【発明の名称】 波長多重双方向光伝送方法および装置

(57) 【要約】

【課題】 局側装置 (OSU) と光源をもたないユーザ装置 (ONU) との間において、簡単な構成でユーザ装置が自律的に送信タイミングを制御し、光信号を双方向伝送する。

【解決手段】 OSUから各ONUに供給する上り信号用の無変調光として、各ONUに割り当てた波長を含み、平坦で連続スペクトルを有する広帯域パルス光を例えばビットレート周期で周期的に送信する。この広帯域パルス光は、波長ルータに入力されると、各ONUに割り当てられた波長の単一波長パルス光として切り出され、それぞれ対応するポートから各ONUに伝送される。しかも、各単一波長パルス光は周期的に各ONUに入力されるので、各ONUでは適当なタイミングの単一波長パルス光を選択し、変調して上り信号として折り返す。



【特許請求の範囲】

【請求項1】 局側装置(ONU)と、光源をもたない複数のユーザ装置(ONU)との間を波長ルータおよび光ファイバ伝送路を介して接続し、局側装置は各ユーザ装置へ伝送する下り信号として各ユーザ装置に割り当てた波長の変調光を無変調光とともに送信し、各ユーザ装置はそれぞれ割り当てられた波長の変調光を受信し、無変調光を変調して上り信号として折り返し送信する波長多重双方向光伝送方法において、

前記局側装置は、前記無変調光として、前記ユーザ装置に割り当てた波長を含み、平坦で連続スペクトルを有する広帯域パルス光を周期的に送信し、

前記波長ルータは、前記局側装置から送信された変調光および無変調光(広帯域パルス光)を入力し、前記各ユーザ装置に割り当てた波長の変調光を分波し、さらに前記無変調光(広帯域パルス光)から前記各ユーザ装置に割り当てた波長の無変調光(単一波長パルス光)を切り出し、前記各ユーザ装置に対応するポートからそれぞれ対応する波長の変調光および無変調光(単一波長パルス光)を各ユーザ装置に送信し、

前記各ユーザ装置は、周期的に入力される前記無変調光(単一波長パルス光)から所定のタイミングの無変調光(単一波長パルス光)を選択して変調し、他の無変調光(単一波長パルス光)を終端することを特徴とする波長多重双方向光伝送方法。

【請求項2】 請求項1に記載の波長多重双方向光伝送方法において、

前記局側装置から下り信号として送信される各ユーザ装置に割り当てた波長の変調光と、上り信号用の無変調光(広帯域パルス光)が異なる波長帯に設定されることを特徴とする波長多重双方向光伝送方法。

【請求項3】 請求項1に記載の波長多重双方向光伝送方法において、

前記局側装置から下り信号として送信される各ユーザ装置に割り当てた波長の変調光と、上り信号用の無変調光(広帯域パルス光)が同一の波長帯に設定され、かつ異なるタイムスロットで送信されることを特徴とする波長多重双方向光伝送方法。

【請求項4】 請求項1に記載の波長多重双方向光伝送方法において、

前記ユーザ装置が周期的に入力される前記無変調光(単一波長パルス光)を変調する送信タイミングは、前記各ユーザ装置から送信された上り信号が前記局側装置に互いに異なるタイミングで受信されるように選択されることを特徴とする波長多重双方向光伝送方法。

【請求項5】 請求項4に記載の波長多重双方向光伝送方法において、

前記ユーザ装置が選択する送信タイミングは、前記局側装置から各ユーザ装置に通知されることを特徴とする波長多重双方向光伝送方法。

【請求項6】 局側装置(ONU)と、光源をもたない複数のユーザ装置(ONU)との間を波長ルータおよび光ファイバ伝送路を介して接続し、局側装置は各ユーザ装置へ伝送する下り信号として各ユーザ装置に割り当てた波長の変調光を無変調光とともに送信し、各ユーザ装置はそれぞれ割り当てられた波長の変調光を受信し、無変調光を変調して上り信号として折り返し送信する波長多重双方向光伝送装置において、

前記局側装置は、

10 前記各ユーザ装置に割り当てた波長の変調光を送信する多波長光源と、

前記無変調光として、前記ユーザ装置に割り当てた波長を含み、平坦で連続スペクトルを有する広帯域パルス光を周期的に送信する広帯域パルス光源とを備えたことを特徴とする波長多重双方向光伝送装置。

【請求項7】 請求項6に記載の波長多重双方向光伝送装置において、

前記広帯域パルス光源は、スーパーコンティニウム(SC)光源であることを特徴とする波長多重双方向光伝送装置。

20 【請求項8】 請求項6に記載の波長多重双方向光伝送装置において、

前記波長ルータは、前記局側装置から送信された変調光および無変調光(広帯域パルス光)を入力し、前記各ユーザ装置に割り当てた波長の変調光を分波し、さらに前記無変調光(広帯域パルス光)から前記各ユーザ装置に割り当てた波長の無変調光(単一波長パルス光)を切り出し、前記各ユーザ装置に対応するポートからそれぞれ対応する波長の変調光および無変調光(単一波長パルス光)を各ユーザ装置に送信する構成であることを特徴とする波長多重双方向光伝送装置。

【請求項9】 請求項8に記載の波長多重双方向光伝送装置において、

前記波長ルータは、アレイ導波路回折格子(AWG)であることを特徴とする波長多重双方向光伝送装置。

【請求項10】 請求項6に記載の波長多重双方向光伝送装置において、

前記各ユーザ装置は、

40 それぞれ割り当てられた波長の変調光および無変調光(単一波長パルス光)を分波または分岐する分波器と、前記変調光を受信する光受信器と、

前記分波器を介して周期的に入力される無変調光(単一波長パルス光)から所定のタイミングの無変調光(単一波長パルス光)を選択して変調し、他の無変調光(単一波長パルス)を終端する光変調器とを備えたことを特徴とする波長多重双方向光伝送装置。

【発明の詳細な説明】

【0001】

50 【発明の属する技術分野】 本発明は、局側装置(ONU)と光源をもたないユーザ装置(ONU)との間で光

信号を双方向伝送する波長多重双方向光伝送方法および装置に関する。

【0002】

【従来の技術】図9は、従来の双方向光伝送システムの構成例を示す（特開平6-350566号公報）。ここで、 $\lambda_1, \lambda_2, \dots, \lambda_n$  は、単一の波長帯入に属する波長であり、各波長が  $n$  個のユーザ装置にそれぞれ割り当てられる。

【0003】局側装置（OSU）50の送信部51は、波長  $\lambda_1, \lambda_2, \dots, \lambda_n$  の光信号を時間的に切り換えて送信する。この光信号は、光ファイバ伝送路61を介して波長ルータ60に伝送され、波長ルーティングにより波長対応のポートに分波され、それぞれ対応する光ファイバ伝送路62を介してユーザ装置（ONU）70-1～70-nに伝送される。

【0004】例えば、波長ルータ60の出力ポート#1には波長  $\lambda_1$  の光信号が分波され、光ファイバ伝送路62を介してONU70-1に伝送される。ONU70-1に入力された光信号は光カブラ71で2分岐され、その一方（下り信号）が光受信器72に受信され、他方が上り信号として光変調器73で変調され、光ファイバ伝送路63、波長ルータ60、光ファイバ伝送路64を介してOSU50の受信部52まで伝送される。他のONUとの光信号の送受信についても同様である。OSU50の受信部52は、各ONU70-1～70-nで変調して折り返された波長  $\lambda_1, \lambda_2, \dots, \lambda_n$  の光信号（上り信号）を時間的に切り換えて受信する。

【0005】本システムは、ONUに光源をもたない構成であり、ONUから上り信号として送信するための光をOSUから供給してやる必要がある。その方法として、OSUは、図10(a)に示すように下り信号と異なるタイムスロットで、各ONUに割り当てた波長の無変調光（直流光）を送信し、各ONUがその無変調光を変調して上り信号として折り返すか、図10(b)に示すように各ONUが下り信号から搬送波成分を抽出し、変調して上り信号として折り返す構成がとられる。

【0006】

【発明が解決しようとする課題】従来の双方向光伝送システムは、各ONUごとに下り信号と上り信号に同一波長を割り当てているので、OSUから各ONUに上り信号用の無変調光を専用のタイムスロットで送信するために伝送効率が低下したり、ONUにおいて下り信号から信号成分と上り信号用の搬送波成分を分離抽出するための構成が複雑になる問題点があった。

【0007】また、各ONU70-1～70-nから折り返された波長  $\lambda_1 \sim \lambda_n$  の変調光（上り信号）は波長ルータ60で合波され、光ファイバ伝送路64上に波長多重される。しかし、波長ルータ60と各ONU70-1～70-nとの間の伝送距離（光ファイバ伝送路62、63の長さ）が異なる場合には、光ファイバ伝送路

64上で各ONUからの上り信号の時間位置が入れ替わったり重なることがある。

【0008】例えば、図11に示すように、OSU50からみてONU70-1よりONU70-2が遠い場合を想定する。ONU70-1、70-2宛てにそれぞれ送信された波長  $\lambda_1, \lambda_2$  の下り信号（無変調光）は、各ONUで変調して折り返され、上り信号としてOSU50に到達する。ここで、下り信号が図11(a)のようなタイミングでOSU50から送信された場合には、上り信号はOSU50の到達時点で重なり、受信部52で受信できなくなる。

【0009】これを回避するには、各ONUまでの伝送距離を考慮し、図11(b)に示すように下り信号の送信間隔を空けて送信タイミングをずらすか、図11(c)に示すように下り信号の送信順番を入れ替える必要がある。しかも、このような送信タイミング制御は、OSU50の送信部51で行う必要があり、ONUの数に応じて飛躍的に複雑になる問題点があった。

【0010】また、OSU50の送信部51は、上り信号用の無変調光を送信する場合に上記の送信タイミング制御の他に、波長を時間的に切り換える必要があるので、波長安定化および高速切り換えのための制御装置が必要であった。

【0011】本発明は、局側装置（OSU）と光源をもたないユーザ装置（ONU）との間において、簡単な構成でユーザ装置が自律的に送信タイミングを制御し、光信号を双方向伝送する波長多重双方向光伝送方法および装置を提供することを目的とする。

【0012】

【課題を解決するための手段】本発明の波長多重双方向光伝送方法および装置は、OSUから各ONUに供給する上り信号用の無変調光として、各ONUに割り当てた波長を含み、平坦で連続スペクトルを有する広帯域パルス光を例えばビットレート周期で周期的に送信する。この広帯域パルス光は、波長ルータに入力されると、各ONUに割り当てられた波長の単一波長パルス光として切り出され、それぞれ対応するポートから各ONUに伝送される。しかも、各単一波長パルス光は周期的に各ONUに入力されるので、各ONUでは適当なタイミングの単一波長パルス光を選択し、変調して上り信号として折り返す。これにより、光源をもたないONU側で上り信号の送信タイミングを制御することができる。

【0013】

【発明の実施の形態】（第1の実施形態）図1は、本発明の第1の実施形態を示す。ここでは、局側装置（OSU）から各ユーザ装置（ONU）への伝送方向を下り、逆の伝送方向を上りとする。

【0014】本実施形態では、OSUから各ONUに伝送する変調光に波長帯  $\lambda'$  を割り当て、上り信号用として伝送する無変調光に波長帯  $\lambda$  ( $\neq \lambda'$ ) を割り当て、

さらに波長帯 $\lambda'$ の波長 $\lambda_1 \sim \lambda_n$ 、および波長帯 $\lambda$ の波長 $\lambda_1 \sim \lambda_n$ をそれぞれ各ONUに割り当てる。また、上り信号用としてOSUから送信する波長帯 $\lambda$ の無変調光は、波長 $\lambda_1 \sim \lambda_n$ を含む連続スペクトルを有するパルス状の広帯域パルス光であり、例えばビットレート周期で周期的に送信される。

【0015】局側装置(OSU)10と複数のユーザ装置(ONU)30-1~30-nが、波長ルータ20、下りの光ファイバ伝送路21、22、上りの光ファイバ伝送路23、24を介して接続される構成は従来と同様である。

【0016】本実施形態のOSU10の送信部11は、波長 $\lambda_1 \sim \lambda_n$ の変調光を時間的に切り換え、波長帯 $\lambda$ の無変調光(広帯域パルス光)とともに、下り信号として光ファイバ伝送路21に送信する(詳しくは図2を参照して説明する)。波長ルータ20は、波長 $\lambda_1 \sim \lambda_n$ の変調光を分波するとともに、波長帯 $\lambda$ の無変調光(広帯域パルス光)から波長 $\lambda_1 \sim \lambda_n$ の無変調光(単一波長パルス光)を切り出し、それぞれ対応する光ファイバ伝送路22を介してONU30-1~30-nに送信する(詳しくは図3を参照して説明する)。

【0017】各ONU30-1~30-nは、それぞれ波長 $\lambda_1 \sim \lambda_n$ の変調光を受信し、波長 $\lambda_1 \sim \lambda_n$ の無変調光(単一波長パルス光)を変調して上り信号として送信する(詳しくは図4を参照して説明する)。波長 $\lambda_1 \sim \lambda_n$ の変調光は、上り信号として光ファイバ伝送路23、波長ルータ20、上りの光ファイバ伝送路24を介してOSU10の受信部15に伝送される。

【0018】図2は、第1の実施形態におけるOSU10の構成例を示す。OSU10の送信部11は、各ONU宛ての送信信号により変調された波長 $\lambda_1 \sim \lambda_n$ の変調光を時間的に切り換えて送信する多波長光源12と、各ONUにおける上り信号用の波長帯 $\lambda$ の無変調光(広帯域パルス光)を周期的に送信する広帯域パルス光源13と、各波長の変調光および無変調光(広帯域パルス光)を合波する合波器14とにより構成される。なお、広帯域パルス光源13には、スーパーコンティニューム(SC)光源を用いることができる。OSU10の受信部15は、波長 $\lambda_1 \sim \lambda_n$ の変調光を時分割で受信する光受信器16により構成される。

【0019】ここで、波長帯 $\lambda$ の無変調光は、図2(b)に示すように波長 $\lambda_1 \sim \lambda_n$ を含む連続スペクトルを有するパルス状の広帯域パルス光であり、例えばビットレート周期で送信される。すなわち、時間的に切り換えて送信される波長 $\lambda_1 \sim \lambda_n$ の変調光に対して、それぞれ波長帯 $\lambda$ の無変調光(広帯域パルス光)が波長多重される。

【0020】なお、図1および図2では、各ONU宛ての波長 $\lambda_1 \sim \lambda_n$ の変調光は、多波長光源12から時間的に切り換えて送信されるように説明したが、それに限

定されるものではない。例えば、広帯域パルス光源から出力される広帯域パルス光を各波長ごとに切り出し、それぞれ各ONU宛ての送信信号により変調し、波長多重して送信するようにしてもよい。すなわち、下り信号として送信される各ONU宛ての変調光は、時間軸上で同時に伝送されてもよい。また、上り信号用の無変調光(広帯域パルス光)も任意の周期で周期的に伝送されていけばよい。

【0021】図3は、第1の実施形態における波長ルータ20の機能(下り信号関係)を示す。図3(a)は波長ルータ20の構成であり、下り信号に関する入出力ポートを示す。図3(b)は下り信号のスペクトルである。波長ルータ20には、下り信号として波長 $\lambda_1 \sim \lambda_n$ の変調光および波長帯 $\lambda$ ( $\lambda_1 \sim \lambda_n$ )の無変調光(広帯域パルス光)が入力される。

【0022】図3(c)は波長ルータ20の透過特性とルーティングされるポート#1~#nの関係を示す。波長ルータ20は、波長帯 $\lambda$ に対して波長 $\lambda_1, \lambda_2, \dots, \lambda_n$ の変調光を透過し、波長帯 $\lambda$ に対して波長 $\lambda_1, \lambda_2, \dots, \lambda_n$ の無変調光を透過し、それぞれ所定のポート#1~#nにルーティングする。図3(d)は波長ルータ20のポート#1の出力光スペクトルであり、波長 $\lambda_1$ の変調光と、広帯域パルス光から切り出された波長 $\lambda_1$ の無変調光(単一波長パルス光)が出力される。

【0023】なお、波長ルータ20としてアレイ導波路回折格子(AWG)を用いれば、入力された広帯域パルス光が各波長成分ごとにそれぞれ対応する出力ポートに切り出され、かつ波長精度も高いので、OSU10の送信部11における広帯域パルス光源13には多波長光源のように発振波長を安定化させるための波長制御技術は不要である。

【0024】図4は、第1の実施形態におけるONU30-i(iは1~n)の構成例を示す。なお、ONU30-1~30-nはすべて同一構成である。ONU30-iには、波長ルータ20によってルーティングされた波長 $\lambda_i$ の変調光および波長 $\lambda_i$ の無変調光(単一波長パルス光)が入力される。分波器31は、入力光を波長帯ごとに分波する機能を有し、波長 $\lambda_i$ の変調光は光受信器32に分波され、波長 $\lambda_i$ の無変調光は光変調器33に分波される。光受信器32は波長 $\lambda_i$ の変調光を受信してOSUからの送信信号を検出し、光変調器33は波長 $\lambda_i$ の無変調光をOSUへの送信信号で変調し、上り信号として送信する。

【0025】ここで、光変調器33には、図4(b)に示すように上り信号用として波長 $\lambda_i$ の無変調光(単一波長パルス光)が周期的に入力されるので、所定のタイミングの無変調光を変調し、その他のタイミングのときは光変調器をオフ(駆動電圧オフ)に設定して無変調光を終端する。これにより、ONU30-iは任意のタイミ

ングで波長 $\lambda_i$ の変調光を上り信号として送信することができる。

【0026】なお、ONU30-iの送信タイミングは、各ONU30-1~30-nから送信された波長 $\lambda_1 \sim \lambda_n$ の変調光(上り信号)が、OSU10に到達するときに時間軸上で重ならないように選択される。例えば、図5に示す例では、ONU30-1に波長 $\lambda_1$ の無変調光が周期的に入力され、ONU30-2に波長 $\lambda_2$ の無変調光が周期的に入力されており、それぞれ適当なタイミングaで無変調光を変調して折り返すことにより、OSUに受信される時点で時間軸上に重ならないように並べることができる。

【0027】ただし、各ONUからの波長 $\lambda_1 \sim \lambda_n$ の変調光は、図1に示すように時間軸上に順番に並ぶ必要はなく、所定のガード時間をおいて互いに重ならないければ十分である。そのためには、例えば各ONUが送信要求バケットをOSUに送信し、OSUが各ONUからの送信要求バケットを受信し、それぞれの受信タイミングから計算した各ONUの送信タイミング情報を各ONUに通知し、各ONUがその送信タイミング情報に基づいて変調タイミングを設定する方法をとればよい。

【0028】従来構成では、各ONUに入力される上り信号用の無変調光は1フレームに1つであり、その入力タイミングが自動的に送信タイミングになり、ONU側で送信タイミングを選択することはできなかった。したがって、OSU側でONUの送信タイミングを考慮して上り信号用の無変調光を送信する必要があった。それに対して、本発明の構成では、ONU30-iに波長 $\lambda_i$ の無変調光が周期的に入力され、あたかもONU30-iが波長 $\lambda_i$ のパルス光源をもっているのと同じ状態になる。これにより、ONU側で送信タイミングを調整できるので、OSUの広帯域パルス光源は周期的に広帯域パルス光を送信するだけでよく、各ONUに合わせて送信タイミングを調整する必要はない。

【0029】(第2の実施形態)図6は、本発明の第2の実施形態の構成例を示す。図において、光ファイバ伝送路25は双方向に光信号を送信する構成であり、光カブラ26は上り信号と下り信号を分離する。その他の構成は第1の実施形態と同様である。

【0030】すなわち、本実施形態では、OSU10から波長ルータ20に伝送される下り信号と、波長ルータ20からOSU10に伝送される上り信号とを共通の光ファイバ伝送路25を介して双方向に伝送する。この場合には、光カブラ26または光サーキュレータを介して、光ファイバ伝送路25とOSU10の送信部および受信部を接続する。

【0031】また、波長ルータ20から各ONU30-1~30-nに伝送される下り信号と、各ONU30-1~30-nから波長ルータ20に伝送される上り信号とをそれぞれ共通の光ファイバ伝送路25を介して双方

向に伝送する。この場合には、光カブラ26または光サーキュレータを介して、光ファイバ伝送路25とONU30-1~30-nの分波器および光変調器を接続する。

【0032】(第3の実施形態)図7は、本発明の第3の実施形態の構成例を示す。本実施形態は、OSU10から波長ルータ20に伝送される下り信号の変調光と無変調光(広帯域パルス光)とをそれぞれ個別の光ファイバ伝送路21-1、21-2を介して伝送する構成である。波長ルータ20は、光ファイバ伝送路21-1を介して伝送された波長 $\lambda_1 \sim \lambda_n$ の変調光と、光ファイバ伝送路21-2を介して伝送された波長帯 $\lambda$ の無変調光を入力し、各ONU対応に分波する。例えば、波長 $\lambda_1$ の変調光と波長 $\lambda_1$ の無変調光を合流し、光ファイバ伝送路22を介してONU30-1に送信する。

【0033】(第4の実施形態)図8は、本発明の第4の実施形態の構成例を示す。本実施形態は、下り信号の変調光と無変調光(広帯域パルス光)とをそれぞれ個別の光ファイバ伝送路を介して伝送する場合に、無変調光(広帯域パルス光)を送信する光ファイバ伝送路と波長ルータ20からOSU10に伝送される上り信号とを共通の光ファイバ伝送路25を介して双方向に伝送する構成である。

【0034】(他の実施形態)各ONU30-1~30-nに割り当てられる波長は、下り信号と上り信号でそれぞれ1つの波長帯に限定する必要はなく、それぞれ2以上の波長帯を割り当ててもよい。この場合には、波長ルータ20として用いるアレイ導波路回折格子(AWG)の周期性を利用し、各波長帯のそれぞれ周期的に対応する波長を各ONUに割り当てればよい。

【0035】また、以上説明した実施形態は、OSU10から各ONU30-1~30-nに伝送される下り信号の変調光の帯域と、上り信号用として伝送される無変調光の帯域が異なるものとして説明した。しかし、両帯域を同一とし、従来のように両信号を異なるタイムスロットで伝送する構成としてもよい。このような構成としても、OSU10から広帯域パルス光を周期的に送信し、波長ルータ20で各ONUに対応する波長の単一波長パルス光を切り出し、各ONU30-1~30-nで周期的に入力される単一波長パルス光から任意の送信タイミングを選択できる本発明の特徴は活かされる。

【0036】

【発明の効果】以上説明したように、本発明の波長多重双方向光伝送方法および装置は、各ONUの上り信号用にOSUから無変調光(広帯域パルス光)を周期的に送信する構成であるので、OSUで波長制御や送信タイミング制御を行う必要がなく、装置規模および消費電力の軽減を図ることができる。

【0037】また、各ONUにおいて送信タイミングの制御を行うことができる。すなわち、各ONUは周期的

に入力される無変調光（単一波長パルス光）から所定のタイミングのものを変調し、他の無変調光（単一波長パルス光）を終端することにより、任意の送信タイミングを選択することができる。これにより、OSUから供給される無変調光を変調して折り返すONUにおいて、その送信タイミングを独自に制御し、OSUの受信部における各ONUからの上り信号の衝突を回避することができる。

【0038】また、収容するONU数が変化した場合に、従来構成ではOSUにおいて上り信号用の多波長光源の設定および波長ルータの設定を変更する必要があるが、本発明は上り信号用としてOSUから広帯域パルス光を周期的に送信する構成であるので、上り信号用の光源の設定変更は不要であり、波長ルータの設定のみを変更するだけで対応することができる。

【図面の簡単な説明】

【図1】本発明の第1の実施形態の構成例を示す図。

【図2】第1の実施形態におけるOSU10の構成例を示す図。

【図3】第1の実施形態における波長ルータ20の機能（下り信号関係）を示す図。

【図4】第1の実施形態におけるONU30-i（iは1～n）の構成例を示す図。

【図5】ONU30-iの送信タイミングを説明する図。

【図6】本発明の第2の実施形態の構成例を示す図。

【図7】本発明の第3の実施形態の構成例を示す図。

【図8】本発明の第4の実施形態の構成例を示す図。

【図9】従来の双方向光伝送システムの構成例を示す

\* 図。

【図10】従来の双方向光伝送システムにおける各ONUの波長割り当て例を示す図。

【図11】従来の双方向光伝送システムの問題点を説明する図。

【符号の説明】

10 局側装置（OSU）

11 送信部

12 多波長光源

13 広帯域パルス光源

14 合波器

15 受信部

16 光受信器

20 波長ルータ

21, 22, 23, 24, 25 光ファイバ伝送路

26 光カブラ

30 ユーザ装置（ONU）

31 分波器

32 光受信器

33 光変調器

50 局側装置（OSU）

51 送信部

52 受信部

60 波長ルータ

61, 62, 63, 64 光ファイバ伝送路

70 ユーザ装置（ONU）

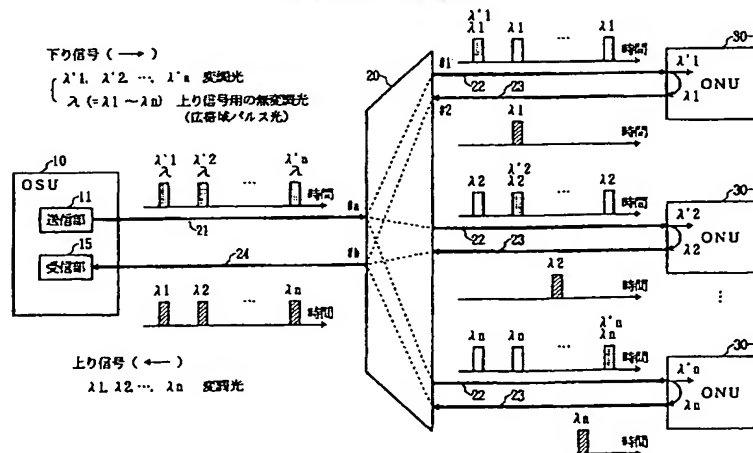
71 光カブラ

72 光受信器

73 光変調器

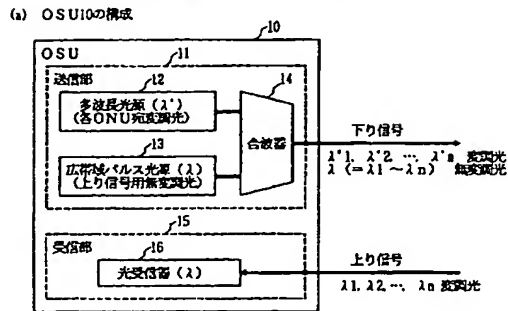
【図1】

本発明の第1の実施形態

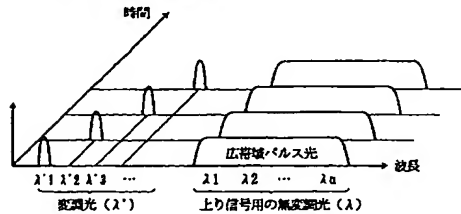


【図2】

第1の実施形態におけるOSU10の構成例

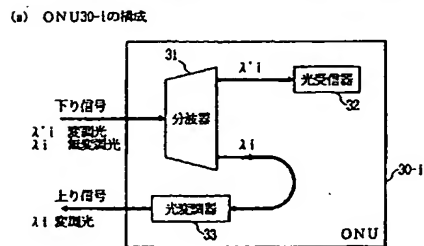


(b) 下り信号のスペクトル/時間波形

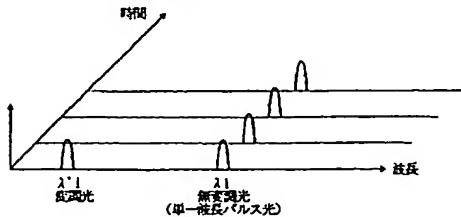


【図4】

第1の実施形態におけるONU30-iの構成例

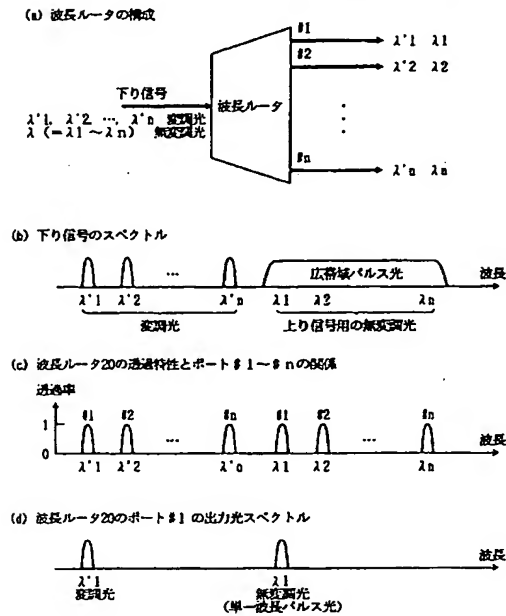


(b) 下り信号のスペクトル/時間波形



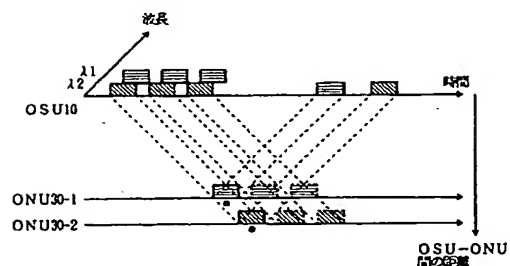
【図3】

第1の実施形態における波長ルータ20の機能(下り信号関係)



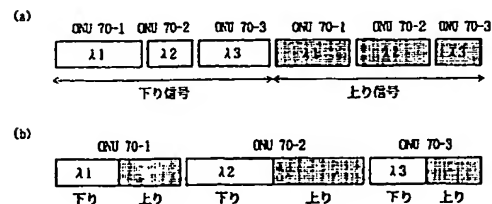
【図5】

ONU30-iの送信タイミングの説明



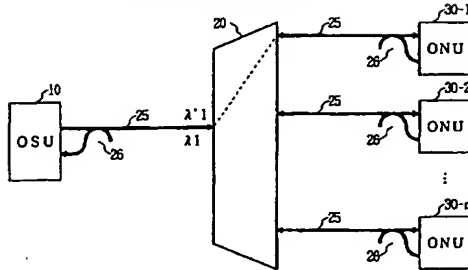
【図10】

従来の双方向光伝送システムにおける各ONUの波長割り当て例



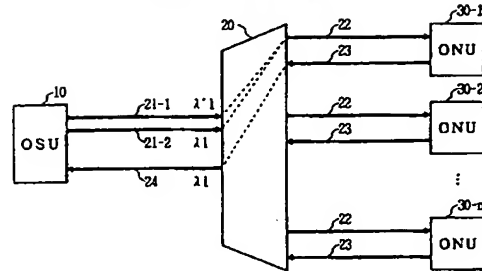
【図6】

本発明の第2の実施形態



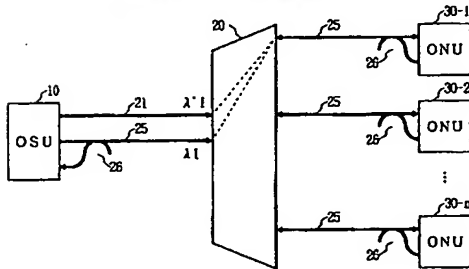
【図7】

本発明の第3の実施形態



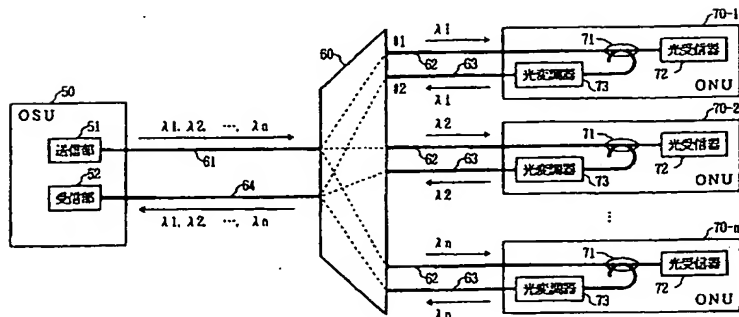
【図8】

本発明の第4の実施形態

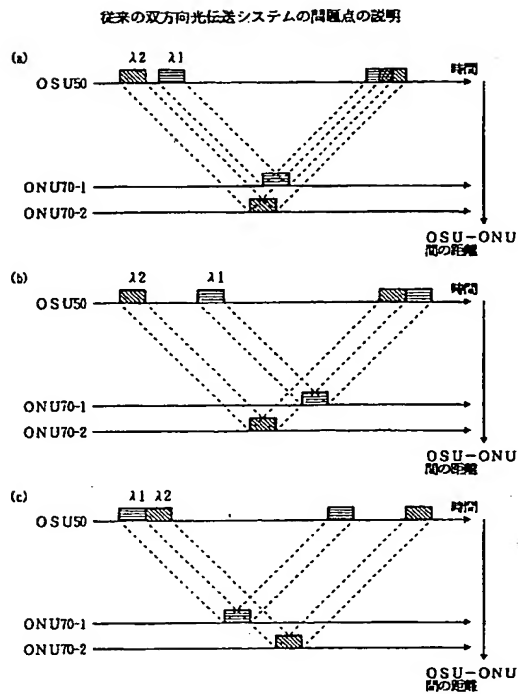


【図9】

従来の双方向光伝送システムの構成例



【図11】



フロントページの続き

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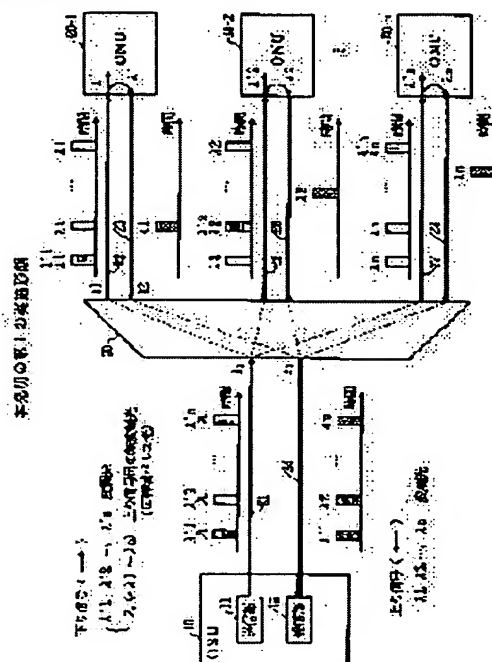
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## (54) METHOD AND DEVICE FOR WAVELENGTH MULTIPLE TWO-WAY OPTICAL TRANSMISSION

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To allow a user device to autonomously control transmission timing and to bidirectionally transmit an optical signal with a simple configuration between a station side device (OSU) and the user device (ONU) that does not have a light source.

**SOLUTION:** Broadband pulse light including a wavelength allocated to each ONU as non-modulation light for an up signal supplied from the OSU to each ONU and having a flat and continuous spectrum is periodically transmitted, for instance in a bit rate period. When the broadband pulse light is inputted to a wavelength router, the broadband pulse light is cut out as the single wavelength pulse light of the wavelength allocated to each ONU and respectively transmitted to each ONU from corresponding ports. Because each single wavelength pulse light is also periodically inputted to each ONU, each ONU selects single wavelength pulse light at appropriate timing and modulates and returns the single wavelength pulse light as an up signal.



## LEGAL STATUS

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## CLAIMS

## [Claim(s)]

[Claim 1] Between station side equipment (OSU) and two or more user equipments (ONU) without the light source is connected through a wavelength router and an optical-fiber-transmission way. Station side equipment transmits the modulation light of the wavelength which is transmitted to each user equipment and which it got down and was assigned to each user equipment as a signal with a light non-become irregular. In the wavelength multiplexing bidirectional optical transmission approach which each user equipment receives the modulation light of the assigned wavelength, respectively, modulates a light non-become irregular, goes up, and is transmitted by return as a signal said station side equipment As said light non-become irregular, including the wavelength assigned to said user equipment, it is flat and the broadband pulsed light which has a continuous spectrum is transmitted periodically. Said wavelength router The modulation light and a light (broadband pulsed light) non-become irregular which were transmitted from said station side equipment are inputted. Separate spectrally the modulation light of the wavelength assigned to said each user equipment, and a light (single wavelength pulsed light) of the wavelength further assigned to said each user equipment from said light (broadband pulsed light) non-become irregular non-become irregular is started. The modulation light and a light (single wavelength pulsed light) non-become irregular of wavelength which correspond from the port corresponding to said each user equipment, respectively are transmitted to each user equipment. Said each user equipment The wavelength multiplexing bidirectional optical transmission approach characterized by choosing a light (single wavelength pulsed light) of predetermined timing non-become irregular from said light (single wavelength pulsed light) inputted periodically non-become irregular, becoming irregular, and carrying out termination of other light (single wavelength pulsed light) non-become irregular.

[Claim 2] The wavelength multiplexing bidirectional optical transmission approach characterized by being set as the wavelength range from which the modulation light of the wavelength assigned to each user equipment which gets down from said station side equipment, and is transmitted as a signal in the wavelength multiplexing bidirectional optical transmission approach according to claim 1, and a light for uphill signals (broadband pulsed light) non-become irregular differ.

[Claim 3] The wavelength multiplexing bidirectional optical transmission approach characterized by being transmitted by time slot which is set as a wavelength range with same modulation light of the wavelength assigned to each user equipment which gets down from said station side equipment, and is transmitted as a signal in the wavelength multiplexing bidirectional optical transmission approach according to claim 1 and light for uphill signals (broadband pulsed light) non-become irregular, and is different.

[Claim 4] The transmit timing which modulate said light ( single wavelength pulsed light) into which said user equipment be input periodically non- become irregular in the wavelength multiplexing bidirectional optical transmission approach according to claim 1 be the wavelength multiplexing bidirectional optical transmission approach characterize by be choose so that it may be receive to the timing which be transmitted from said each user equipment, and from which it go up and a signal differ mutually to said station side equipment.

[Claim 5] The transmit timing which said user equipment chooses in the wavelength multiplexing bidirectional optical transmission approach according to claim 4 is the wavelength multiplexing bidirectional optical transmission approach characterized by what is notified to each user equipment from said station side equipment.

[Claim 6] Between station side equipment (OSU) and two or more user equipments (ONU) without the light source is connected through a wavelength router and an optical-fiber-transmission way. Station side equipment transmits the modulation light of the wavelength which is transmitted to each user equipment and which it got down and was assigned to each user equipment as a signal with a light non-become irregular. In the wavelength multiplexing bidirectional optical transmission device which each user equipment receives the modulation light of the assigned wavelength, respectively, modulates a light non-become irregular, goes up, and is transmitted by return as a signal said station side equipment The multi-wavelength light source which transmits the modulation light of the wavelength assigned to said each user equipment, The wavelength multiplexing bidirectional optical transmission device characterized by having the source of broadband pulsed light which transmits periodically the broadband pulsed light which is flat and has a continuous spectrum as said light non-become irregular including the wavelength assigned to said user equipment.

[Claim 7] It is the wavelength multiplexing bidirectional optical transmission device characterized by said source of broadband pulsed light being the super Continuum (SC) light source in a wavelength multiplexing bidirectional optical transmission device according to claim 6.

[Claim 8] In a wavelength multiplexing bidirectional optical transmission device according to claim 6 said wavelength router The modulation light and a light (broadband pulsed light) non-become irregular which were transmitted from said station side equipment are inputted. Separate spectrally the modulation light of the wavelength assigned to said each user equipment, and a light (single wavelength pulsed light) of the wavelength further assigned to said each user equipment from said light (broadband pulsed light) non-become irregular non-become irregular is started. The wavelength multiplexing bidirectional optical transmission device characterized by being the configuration of transmitting the modulation light and a light (single wavelength pulsed light) non-become irregular of wavelength which correspond from the port corresponding to said each user equipment, respectively to each user equipment.

[Claim 9] It is the wavelength multiplexing bidirectional optical transmission device characterized by said wavelength router being an array waveguide diffraction grating (AWG) in a wavelength multiplexing bidirectional optical transmission device according to claim 8.

[Claim 10] In a wavelength multiplexing bidirectional optical transmission device according to claim 6 said each user equipment The splitter which separates spectrally or branches the modulation light and a light (single wavelength pulsed light) non-become irregular of

wavelength which were assigned, respectively, Choose a light (single wavelength pulsed light) of predetermined timing non-become irregular from a light (single wavelength pulsed light) periodically inputted through the optical receiver which receives said modulation light, and said splitter non-become irregular, and it becomes irregular. The wavelength multiplexing bidirectional optical transmission device characterized by having the optical modulator which carries out termination of other light (single wavelength pulse) non-become irregular.

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[Translation done.]

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## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the wavelength multiplexing bidirectional optical transmission approach and equipment which carry out bidirectional transmission of the lightwave signal between station side equipment (OSU) and user equipment (ONU) without the light source.

[0002]

[Description of the Prior Art] Drawing 9 shows the example of a configuration of the conventional bidirectional lightwave transmission system (JP,6-350566,A). Here, they are  $\lambda_1$ ,  $\lambda_2$ , ...,  $\lambda_n$ . It is the wavelength belonging to the single wavelength range  $\lambda$ , and is assigned to the user equipment each wavelength of whose is  $n$  pieces, respectively.

[0003] The transmitting section 51 of station side equipment (OSU) 50 is wavelength  $\lambda_1$ ,  $\lambda_2$ , ...,  $\lambda_n$ . A lightwave signal is switched in time and it transmits. This lightwave signal is transmitted to the wavelength router 60 through the optical-fiber-transmission way 61, and it is separated spectrally into the port of wavelength correspondence by wavelength routing, and it is transmitted to user equipment (ONU) 70-1 - 70-n through the optical-fiber-transmission way 62 which corresponds, respectively.

[0004] For example, in output port \*1 of the wavelength router 60, it is wavelength  $\lambda_1$ . A lightwave signal is separated spectrally and it is transmitted to ONU 70-1 through the optical-fiber-transmission way 62. It dichotomizes with the optical coupler 71 and one (getting down signal) of these is received by the optical receiver 72, and another side goes up, it becomes irregular with an optical modulator 73 as a signal, and the lightwave signal inputted into ONU 70-1 is transmitted to the receive section 52 of OSU50 through the optical-fiber-transmission way 63, the wavelength router 60, and the optical-fiber-transmission way 64. The same is said of transmission and reception of a lightwave signal with other ONU. The receive section 52 of OSU50 is the wavelength  $\lambda_1$  modulated and turned up by each ONU 70-1 - 70-n,  $\lambda_2$ , ...,  $\lambda_n$ . A lightwave signal (uphill signal) is switched in time, and it receives.

[0005] This system is a configuration which does not have the light source in ONU, and needs to supply the light for going up from ONU and transmitting as a signal from OSU. As the approach, OSU is drawing 10 (a). It is a time slot which gets down and is different from a signal so that it may be shown, a light (direct-current light) of the wavelength assigned to each ONU non-become irregular transmits, each ONU modulates the light non-become irregular, and goes up, and it turns up as a signal, or is drawing 10 (b). The configuration which each ONU gets down, and extracts a carrier component, modulates, goes up from a signal, and turns up as a signal so that it may be shown is taken.

[0006]

[Problem(s) to be Solved by the Invention] Since the conventional bidirectional lightwave transmission system got down for every ONU, went up with the signal and was assigning the same wavelength to the signal, in order to go up from OSU to each ONU and to transmit by the time slot of dedication of a light for signals non-become irregular, transmission efficiency fell, and it had the trouble that the configuration for getting down in ONU, going up from a signal with a signal component, and carrying out the separation extract of the carrier component for signals became complicated.

[0007] Moreover, wavelength  $\lambda_1$  -  $\lambda_n$  which were turned up from each ONU 70-1 - 70-n It is multiplexed with the wavelength router 60 and wavelength multiplexing of the modulation light (uphill signal) is carried out on the optical-fiber-transmission way 64. However, when the transmission distances between the wavelength router 60, and each ONU 70-1 - 70-n (the die length of the optical-fiber-transmission ways 62 and 63) differ, the time amount location of the going-up signal from each ONU may interchange on the optical-fiber-transmission way 64, or it may lap.

[0008] For example, as shown in drawing 11, the case where ONU 70-2 is further than ONU 70-1 is assumed, in view of OSU50. ONU 70-1, the wavelength  $\lambda_1$  transmitted to 70-2, respectively, and  $\lambda_2$  It gets down, and a signal (light non-become irregular) is modulated and turned up by each ONU, and reaches OSU50 as an uphill signal. Here, it gets down and a signal is drawing 11 (a). When transmitted from OSU50 to timing [like], it is an uphill signal at the attainment time of OSU50, it laps, and it becomes impossible to receive it in a receive section 52.

[0009] In order to avoid this, the transmission distance to each ONU is taken into consideration, and it is drawing 11 (b). It gets down so that it may be shown, and transmitting spacing of a signal is vacated, and transmit timing is shifted, or it is drawing 11 (c). It is necessary to get down and to replace the transmitting sequence of a signal so that it may be shown. And such transmit timing control needed to be performed in the transmitting section 51 of OSU50, and there was a trouble which becomes complicated by leaps and bounds according to the number of ONU.

[0010] Moreover, since the transmitting section 51 of OSU50 needed to switch the wavelength other than the above-mentioned transmit timing control in time when a light for uphill signals non-become irregular was transmitted, the control unit for wavelength stabilization and a high-speed switch was required for it.

[0011] User equipment controls transmit timing by the easy configuration autonomously between station side equipment (OSU) and user equipment (ONU) without the light source, and this invention aims at offering the wavelength multiplexing bidirectional optical transmission approach and equipment which carry out bidirectional transmission of the lightwave signal.

[0012]

[Means for Solving the Problem] As a light for uphill signals supplied to each ONU from OSU non-become irregular, including the wavelength assigned to each ONU, the wavelength multiplexing bidirectional optical transmission approach and equipment of this invention are flat, and transmit periodically the broadband pulsed light which has a continuous spectrum for example, a bit rate period. If this broadband pulsed light is inputted into a wavelength router, it will be started as single wavelength pulsed light of the wavelength assigned to each ONU, and will be transmitted to each ONU from the port which corresponds, respectively. And since it is periodically inputted into each ONU, the single wavelength pulsed light of suitable timing is chosen, it becomes irregular, and each single wavelength pulsed light goes up by each ONU, and is turned up as a signal. It can go up by the ONU side without the light source by this, and the transmit timing of a signal can be controlled.

[0013]

[Embodiment of the Invention] (1st operation gestalt) Drawing 1 shows the 1st operation gestalt of this invention. Here, it gets down from the transmission direction from station side equipment (OSU) to each user equipment (ONU), and the reverse transmission direction is considered as going up.

[0014] a light which assigns wavelength range  $\lambda$  to the modulation light transmitted to each ONU from OSU with this operation gestalt, and is transmitted as an object for uphill signals non-become irregular -- a wavelength range  $\lambda$  ( $=\lambda$ ) -- assigning -- further -- the wavelength  $\lambda_1$  of wavelength range  $\lambda - \lambda_n$ , and the wavelength  $\lambda_1$  of a wavelength range  $\lambda - \lambda_n$ . It assigns each ONU, respectively. Moreover, a light of the wavelength range  $\lambda$  which transmits from OSU as an object for uphill signals non-become irregular is wavelength  $\lambda_1 - \lambda_n$ . It is the pulse-like broadband pulsed light which has the included continuous spectrum, for example, is transmitted periodically a bit rate period.

[0015] Station side equipment (OSU) 10, two or more user equipments (ONU) 30-1 - 30-n of the configuration connected through the wavelength router 20, the optical-fiber-transmission ways 21 and 22 from which it gets down, and the uphill optical-fiber-transmission ways 23 and 24 are the same as usual.

[0016] The transmitting section 11 of OSU10 of this operation gestalt switches the modulation light of wavelength  $\lambda_1 - \lambda_n$  in time, and with a light (broadband pulsed light) of a wavelength range  $\lambda$  non-become irregular, it gets down and it transmits to the optical-fiber-transmission way 21 as a signal (with reference to drawing 2, it explains in detail). The wavelength router 20 is a light (broadband pulsed light) of a wavelength range  $\lambda$  non-become irregular to the wavelength  $\lambda_1 - \lambda_n$  while separating spectrally the modulation light of wavelength  $\lambda_1 - \lambda_n$ . A light (single wavelength pulsed light) non-become irregular is started, and it transmits to ONU 30-1 - 30-n through the optical-fiber-transmission way 22 which corresponds, respectively (with reference to drawing 3, it explains in detail).

[0017] Each ONU 30-1 - 30-n receive the modulation light of wavelength  $\lambda_1 - \lambda_n$ , respectively, and are wavelength  $\lambda_1 - \lambda_n$ . A light (single wavelength pulsed light) non-become irregular is modulated, and it goes up, and transmits as a signal (with reference to drawing 4, it explains in detail). Wavelength  $\lambda_1 - \lambda_n$  Modulation light is transmitted to the receive section 15 of OSU10 through the optical-fiber-transmission way 23, the wavelength router 20, and the uphill optical-fiber-transmission way 24 as an uphill signal.

[0018] Drawing 2 shows the example of a configuration of OSU10 in the 1st operation gestalt. The multi-wavelength light source 12 which the transmitting section 11 of OSU10 switches in time the modulation light of the wavelength  $\lambda_1$  modulated by the sending signal of each addressing to ONU -  $\lambda_n$ , and is transmitted, It is constituted by the source 13 of broadband pulsed light which transmits periodically a light (broadband pulsed light) of the wavelength range  $\lambda$  for uphill signals in each ONU non-become irregular, and the multiplexing machine 14 which multiplexes the modulation light and a light (broadband pulsed light) non-become irregular of each wavelength. In addition, the super Continuum (SC) light source can be used for the source 13 of broadband pulsed light. The receive section 15 of OSU10 is wavelength  $\lambda_1 - \lambda_n$ . It is constituted by the optical receiver 16 which receives modulation light by time sharing.

[0019] Here, a light of a wavelength range  $\lambda$  non-become irregular is drawing 2 (b). They are wavelength  $\lambda_1 - \lambda_n$  so that it may be shown. It is the pulse-like broadband pulsed light which has the included continuous spectrum, for example, is transmitted a bit rate period. That is, wavelength multiplexing of the light (broadband pulsed light) of a wavelength range  $\lambda$  non-become irregular is carried out to the modulation light of the wavelength  $\lambda_1$  which switches in time and is transmitted -  $\lambda_n$ , respectively.

[0020] In addition, although drawing 1 and drawing 2 explained that the modulation light of the wavelength  $\lambda_1$  of each addressing to ONU -  $\lambda_n$  was switched in time, and was transmitted from the multi-wavelength light source 12, it is not limited to it. For example, the broadband pulsed light outputted from the source of broadband pulsed light is started for every wavelength, it becomes irregular by the sending signal of each addressing to ONU, respectively, wavelength multiplexing is carried out, and you may make it transmit. That is, the modulation light of each addressing to ONU which gets down and is transmitted as a signal may be transmitted to coincidence on a time-axis. Moreover, a light for uphill signals (broadband pulsed light) non-become irregular should just also be periodically transmitted with the period of arbitration.

[0021] Drawing 3 shows the function (getting down signal relation) of the wavelength router 20 in the 1st operation gestalt. Drawing 3 (a) It is the configuration of the wavelength router 20, and it gets down and the input/output port about a signal is shown. Drawing 3 (b) It gets down and is the spectrum of a signal. It gets down to the wavelength router 20, and the modulation light of wavelength  $\lambda_1 - \lambda_n$  and a light (broadband pulsed light) of a wavelength range  $\lambda$  ( $\lambda_1 - \lambda_n$ ) non-become irregular are inputted into it as a signal.

[0022] Drawing 3 (c) The relation of port  $**1 - **n$  by which routing is carried out to the transparency property of the wavelength router 20 is shown. The wavelength router 20 is wavelength range  $\lambda$ . It receives, wavelength  $\lambda_1$ ,  $\lambda_2$ , --, the modulation light of  $\lambda_n$  are penetrated, and they are wavelength  $\lambda_1$ ,  $\lambda_2$ , --,  $\lambda_n$  to a wavelength range  $\lambda$ . A light non-become irregular is penetrated and routing is carried out to predetermined port  $**1 - **n$ , respectively. Drawing 3 (d) Wavelength  $\lambda_1$  which is the output light spectrum of port  $**1$  of the wavelength router 20, and was started from the modulation light and broadband pulsed light of wavelength  $\lambda_1$ . A light (single wavelength pulsed light) non-become irregular is outputted.

[0023] In addition, it is started by the output port where the inputted broadband pulsed light corresponds for every wavelength component, respectively, and since precision of wave length is also high, the wavelength control technique for making the source 13 of broadband pulsed light in the transmitting section 11 of OSU10 stabilize oscillation wavelength like the multi-wavelength light source is unnecessary, if an array waveguide diffraction grating (AWG) is used as a wavelength router 20.

[0024] Drawing 4 shows the example of a configuration of ONU30-i (i1-n) in the 1st operation gestalt. In addition, all of ONU 30-1 - 30-n are the same configurations. Modulation light and wavelength  $\lambda_{da'i}$  of wavelength  $\lambda_{da'i}$  by which routing was carried out to ONU30-i with the wavelength router 20 A light (single wavelength pulsed light) non-become irregular is inputted. It has the function to separate input light spectrally for every wavelength range, the modulation light of wavelength  $\lambda_{da'i}$  is separated spectrally into the optical receiver 32, and a splitter 31 is wavelength  $\lambda_{da'i}$ . A light non-become irregular is separated spectrally into an optical modulator 33. The optical receiver 32 receives the modulation light of wavelength  $\lambda_{da'i}$ , and detects the sending signal from OSU, and an optical modulator 33 is wavelength  $\lambda_{da'i}$ . A light non-become irregular is modulated by the sending signal to OSU, and it transmits as an uphill signal.

[0025] Here, in an optical modulator 33, it is drawing 4 (b). Since it goes up and a light (single wavelength pulsed light) of wavelength  $\lambda_{da'i}$  non-become irregular is periodically inputted as an object for signals so that it may be shown, a light of predetermined timing non-become irregular is modulated, an optical modulator is set as OFF (driver voltage OFF) at the time of other timing, and it carries out termination of the light non-become irregular. Thereby, ONU30-i is wavelength  $\lambda_{da'i}$  at the timing of arbitration. Modulation light can be gone up and it can transmit as a signal.

[0026] In addition, the transmit timing of ONU30-i is the wavelength  $\lambda_{da'1}$  -  $\lambda_{da'n}$  which were transmitted from each ONU 30-1 - 30-n. When modulation light (uphill signal) reaches OSU10, it is chosen so that it may not lap on a time-axis. For example, at the example shown in drawing 5, it is wavelength  $\lambda_{da'1}$  to ONU 30-1. A light non-become irregular is inputted periodically and a light of wavelength  $\lambda_{da'2}$  non-become irregular is periodically inputted into ONU 30-2, and by modulating and turning up a light non-become irregular to the respectively suitable timing a, when received by OSU, it can arrange so that it may not lap on a time-axis.

[0027] However, the wavelength  $\lambda_{da'1}$  from each ONU -  $\lambda_{da'n}$  If modulation light does not need to be located in a line in order on a time-axis as shown in drawing 1, it sets predetermined guard time amount and does not lap mutually, it is enough. For that purpose, what is necessary is for each ONU to transmit a Request-to-Send packet to OSU, for example, and for OSU to receive the Request-to-Send packet from each ONU, to notify the transmit timing information on each ONU calculated from each receiving timing to each ONU, and just to take how each ONU sets up modulation timing based on the transmit timing information.

[0028] Conventionally, with a configuration, the number of the light for uphill signals inputted into each ONU non-become irregular was one, and the input timing was not able to turn into transmit timing automatically, and they was not able to choose transmit timing as one frame by the ONU side. Therefore, in consideration of the transmit timing of ONU, it needed to go up by the OSU side, and a light for signals non-become irregular needed to be transmitted. it -- receiving -- the configuration of this invention -- ONU30-i -- wavelength  $\lambda_{da'i}$  a light non-become irregular inputs periodically -- having -- as -- ONU30-i -- wavelength  $\lambda_{da'i}$  the source of pulsed light -- \*\*\*\* -- it will be in the same condition as being. Thereby, since transmit timing can be adjusted by the ONU side, the source of broadband pulsed light of OSU does not need to adjust transmit timing according to each ONU that what is necessary is just to transmit broadband pulsed light periodically.

[0029] (2nd operation gestalt) Drawing 6 shows the example of a configuration of the 2nd operation gestalt of this invention. In drawing, the optical-fiber-transmission way 25 is the configuration of transmitting a lightwave signal bidirectionally, and the optical coupler 26 gets down with an uphill signal, and separates a signal. Other configurations are the same as that of the 1st operation gestalt.

[0030] That is, with this operation gestalt, the going-up [ which is transmitted to the wavelength router 20 ] signal transmitted to OSU10 from a signal and the wavelength router 20 by getting down is bidirectionally transmitted through the common optical-fiber-transmission way 25 from OSU10. In this case, the transmitting section and the receive section of the optical-fiber-transmission way 25 and OSU10 are connected through the optical coupler 26 or an optical circulator.

[0031] Moreover, the going-up [ which is transmitted to each ONU 30-1 - 30-n ] signal transmitted to the wavelength router 20 from a signal, and each ONU 30-1 - 30-n by getting down is bidirectionally transmitted through the respectively common optical-fiber-transmission way 25 from the wavelength router 20. In this case, the splitter and optical modulator of the optical-fiber-transmission way 25, ONU 30-1 - 30-n are connected through the optical coupler 26 or an optical circulator.

[0032] (3rd operation gestalt) Drawing 7 shows the example of a configuration of the 3rd operation gestalt of this invention. This operation gestalt is a configuration transmitted to the wavelength router 20 from OSU10 of getting down and transmitting the modulation light and a light (broadband pulsed light) non-become irregular of a signal through the optical-fiber-transmission way 21-1 according to individual, and 21-2, respectively. The wavelength router 20 inputs the modulation light of the wavelength  $\lambda_{da'1}$  transmitted through the optical-fiber-transmission way 21-1 -  $\lambda_{da'n}$ , and a light of the wavelength range  $\lambda_{da'}$  transmitted through the optical-fiber-transmission way 21-2 non-become irregular, and separates them spectrally into each ONU correspondence. For example, modulation light of wavelength  $\lambda_{da'1}$  and wavelength  $\lambda_{da'1}$  It joins and a light non-become irregular is transmitted to ONU 30-1 through the optical-fiber-transmission way 22.

[0033] (4th operation gestalt) Drawing 8 shows the example of a configuration of the 4th operation gestalt of this invention. This operation gestalt is the configuration of transmitting bidirectionally the optical-fiber-transmission way which transmits a light (broadband pulsed light) non-become irregular, and the going-up signal transmitted to OSU10 from the wavelength router 20 through the common optical-fiber-transmission way 25, when getting down and transmitting the modulation light and a light (broadband pulsed light) non-become irregular of a signal through the optical-fiber-transmission way according to individual, respectively.

[0034] (Other operation gestalten) It is necessary to get down, the wavelength assigned to each ONU 30-1 - 30-n may go up with a signal, and it is not necessary to limit it to one wavelength range by signal, respectively, and it may assign two or more wavelength ranges, respectively. In this case, what is necessary is to use the periodicity of the array waveguide diffraction grating (AWG) used as a wavelength router 20, and just to assign the wavelength to which each wavelength range corresponds periodically, respectively to each ONU.

[0035] Moreover, the operation gestalt explained above was explained by getting down as that from which the band of a light non-become [ which is transmitted to each ONU 30-1 from OSU10 - 30-n / which is transmitted as the band of the modulation light of a signal and an object for uphill signals ] irregular differs. However, it is good also as a configuration which makes both bands the same and transmits both signals by different time slot like before. Also as such a configuration, broadband pulsed light is periodically transmitted from OSU10, the single wavelength pulsed light of the wavelength corresponding to each ONU is started with the wavelength router 20, and the description of this invention which can choose the transmit timing of arbitration from the single wavelength pulsed light periodically inputted by each ONU 30-1 - 30-n is harnessed.

[0036]

[Effect of the Invention] As explained above, since the wavelength multiplexing bidirectional optical transmission approach and equipment of this invention are the configuration of transmitting a light (broadband pulsed light) non-become irregular from OSU periodically to the going-up signals of each ONU, they need to perform neither wavelength control nor transmit timing control by OSU, and can aim at mitigation of an equipment scale and power consumption.

[0037] Moreover, in each ONU, transmit timing is controllable. That is, each ONU can choose the transmit timing of arbitration by modulating the thing of predetermined timing from a light (single wavelength pulsed light) inputted periodically non-become irregular, and carrying out termination of other light (single wavelength pulsed light) non-become irregular. In ONU which modulates and turns up by this a light supplied from OSU non-become irregular, the transmit timing can be controlled uniquely and the collision of the going-up signal from each ONU in the receive section of OSU can be avoided.

[0038] Moreover, when the number of ONU to hold changes, it is necessary to go up by the configuration in OSU and to change a setup of the multi-wavelength light source for signals, and a setup of a wavelength router with it conventionally, and since this invention is the configuration of transmitting broadband pulsed light periodically from OSU as an object for uphill signals, setting modification of the light source for uphill signals is unnecessary, and it can respond only by changing only a setup of a wavelength router.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

- [Drawing 1] Drawing showing the example of a configuration of the 1st operation gestalt of this invention.
- [Drawing 2] Drawing showing the example of a configuration of OSU10 in the 1st operation gestalt.
- [Drawing 3] Drawing showing the function (getting down signal relation) of the wavelength router 20 in the 1st operation gestalt.
- [Drawing 4] Drawing showing the example of a configuration of ONU30-i (i1-n) in the 1st operation gestalt.
- [Drawing 5] Drawing explaining the transmit timing of ONU30-i.
- [Drawing 6] Drawing showing the example of a configuration of the 2nd operation gestalt of this invention.
- [Drawing 7] Drawing showing the example of a configuration of the 3rd operation gestalt of this invention.
- [Drawing 8] Drawing showing the example of a configuration of the 4th operation gestalt of this invention.
- [Drawing 9] Drawing showing the example of a configuration of the conventional bidirectional lightwave transmission system.
- [Drawing 10] Drawing showing the example of wavelength quota of each ONU in the conventional bidirectional lightwave transmission system.
- [Drawing 11] Drawing explaining the trouble of the conventional bidirectional lightwave transmission system.

[Description of Notations]

- 10 Station Side Equipment (OSU)
- 11 Transmitting Section
- 12 Multi-Wavelength Light Source
- 13 Source of Broadband Pulsed Light
- 14 Multiplexing Machine
- 15 Receive Section
- 16 Optical Receiver
- 20 Wavelength Router
- 21, 22, 23, 24, 25 Optical-fiber-transmission way
- 26 Optical Coupler
- 30 User Equipment (ONU)
- 31 Splitter
- 32 Optical Receiver
- 33 Optical Modulator
- 50 Station Side Equipment (OSU)
- 51 Transmitting Section
- 52 Receive Section
- 60 Wavelength Router
- 61, 62, 63, 64 Optical-fiber-transmission way
- 70 User Equipment (ONU)
- 71 Optical Coupler
- 72 Optical Receiver
- 73 Optical Modulator

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